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Technology in the classroom: Burning the bridges to the gaps in gender-biased education?

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Abstract

This review introduces the concepts of gender bias and technology in education. It discusses the interaction between the two in the educational setting and the effects this interaction may have on teachers, students and materials used in the classroom. It is argued that areas in the educational setting that have been focused on as materials and practices that are biased have also been translated into the use of educational technology that is biased. This review makes the point that biases that have been pointed out and studied within the educational system have not been solved by the use of technology (as some had hoped). In fact, the biases have simply been converted into a new form and may have actually served to undo some the bias-eliminating practices that had been starting to take place in classrooms. Implications and suggestions for change are discussed.

Keywords: Gender studies; Improving classroom teaching

1. Introduction

Gender bias has been an issue in research, media and in our schools for many years now. Many researchers have looked at how and why gender bias manifests itself within our schools. Teachers have been studied to see if they hold gender based expectations, if they treat children differently based on the sex of the child, if they give more attention to one gender over another, and if they give more positive reinforcement to one gender over another. The dynamics of the classroom have also been studied to see if the children themselves are behaving according to socially constructed gender roles, if they treat each other differently based on gender, and if they approach particular subjects differently based on gender.

Another area studied frequently has been the materials used in the classroom. Textbooks have been looked at as information guides to particular subjects. With this in mind, they have been studied to see if they hold gender specific cues to certain subjects, if they undermine or demean one gender over another, and if they hold

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an androcentric or gynocentric point of view. Although the literature on gender biases has made many recommendations to counteract possible existing biases and to prevent new biases from occurring, these recommendations have been overshadowed by the insurgence of technology in the classroom.

Technology in the classroom emerged as an issue for both teachers and students in the early 1980s. Since then, a number of studies have been done on how technology is used in the classroom, what advantages technology in the classroom may hold for teachers and students, and how technology is implemented in the classroom. Technology has become an integral part of learning on a number of levels and can be seen to influence the very areas struggling with gender biases.

Teachers may be using technology in differing amounts based on their own gender (Schofield, 1995) and may hold similar expectations for their students. For example, Schofield (1995) points out that many male teachers in her study reported doing things such as building computers for fun and changing their teaching to include computer science simply because they were interested in it. None of the female teachers in her study reported a similar interest in computers or technology. Students may have a socially constructed idea of what technology is, how it is used, and who should be using it. If students are only being taught computer skills by male teachers, they may be implicitly learning that boys and men are not only better at this type of skill, but that they should be interested in it more than girls and women are.

Technology itself (e.g., computer software programs, computer lab space) may also be a type of learning material that maintains or promotes gender bias in the classroom by including male lead characters in a majority of software programs or by having limited computer lab space, making it difficult for everyone to get a chance to use technology on a daily basis. The addition of technology to classrooms that may have been resistant to changes toward gender equity could likely serve to take the focus off of the pursuit of bias-free classrooms and exacerbate an already difficult situation.

In the United States, on average, children spend between 3 and 8 hours a day in school for five days per week between the grades of kindergarten and high school graduation. Children learn a lot about life and the world around them simply by going to school. Following high school graduation, many students go on to college or University to further their education, spending even more time in a classroom environment. The research strongly suggests that it is the girls and women in school that are receiving a lack of education due to gender biases. There is also a broad research base that suggests that girls and women receive a lack of education, experience, and opportunities in areas that are stereotypically male, sex-typed subjects such as math and science (Altermatt, Jovanovic, & Perry, 1998), holding them back from careers that generally pay better, have better benefits, and are more stable, such as technologically based career fields which tend have fewer women than men (Lee, 2003; McClelland, 2001). If gender bias, technology and a combination of the two may be serving to hold our female students back from successful careers, in what areas is this lack of education manifested and what do we know about the impact it has in the classroom setting?

The goal of this review is twofold. First, to introduce the main topics and give some background on gender bias and technology. Secondly, to discuss how the two interact in the educational setting and the effects this interaction may have on those involved. The main point being that the areas in the educational setting that have been focused on as materials and practices that are biased (i.e., teachers, students, materials) have also been translated into the use of educational technology that is biased. The main topics of gender bias in education and technology in education will be introduced separately, including only specific areas of interest to be covered. Following backgrounds of research in each area, I will discuss how gender bias and technology interact in the educational setting and how they affect the three main areas of study: teachers, students, and materials. The research backgrounds as well as the integration of the topics are meant to highlight the main areas I have chosen to discuss and are not meant to be comprehensive, as the literature in both gender bias in education and technology in education is vast and ever expanding.

2. Gender bias in education

Sadker and Sadker (1986) stated that the experience of female students in the United States is unique. It would be difficult to find another group that starts out ahead, in reading, in writing, and even in math, and twelve years later finds itself behind. Teachers may play a role in gender bias in the classroom by

holding their own biases or contributing to those held by the children they teach. Some researchers have encouraged the education of teachers to make them aware of gender bias and how to combat bias in their classroom. Others propose that this type of education for teachers may not only reduce bias in the classroom but may also help to give our female students a better chance to obtain careers in math and science oriented fields.

The students in the classrooms also play a large role in gender bias in the educational setting. In fact, according to Vygotsky's sociocultural theory, contact with teachers is only a very small aspect of how a child learns. Socially constructed gender roles are learned as children develop higher-order cognitive functioning through peer social interaction. Learning and upholding socially constructed gender roles is dangerous for the education of young female students. Being taught that math and science are "boys' classes" is detrimental to girls and women trying to gain ground in school and eventually in careers that require math and science backgrounds. This may be more difficult to change. Children learn their biases in many settings, and school is only one way in which these biases may be reinforced.

Textbooks and tests that play a role in the gender inequities that exist in education seem to be the easiest to change, and yet they remain untouched. Texts undergoing new editions can make necessary changes to gender equity, but do not. Standardized tests can be measured to see if they favor boys over girls in any area, but they are not. Although gender bias has been a topic of debate for educators for many years now, it has been set aside to make room for new ways of teaching, growth in the educational environment, and potential improvement in the educational system through the introduction of technology in the classroom.

3. Technology in education

Technology has become an integral part of the educational setting since its debut in the early 1980s. Its use in the classroom has been met with mixed results. Teachers and researchers in the education field have been given the responsibility of infusing technology into their curriculum. Although many teachers can see the benefits technology may have to offer, they are finding it difficult to both learn themselves and teach to students. Many teachers find that certain types of technology in the classroom make presentation of material easier. Others find that it hinders their efforts as students tend to use it for entertainment and not as intended.

Students tend to have a positive perception of using technology in the classroom. It may be the case that being actively involved in class lessons helps them to better understand certain concepts, or they may enjoy having the computers and other technology because it makes school more entertaining for them. Young students that have difficulty understanding how certain types of technology work should not be given lessons in the absence of a teacher or other adult. Secondary education students are aware of the many facets of life technology is now being used in and are able to advance their knowledge in the field faster than some of their instructors may be able to do. Students in higher education are also inundated with technology tools in most programs at the college and university level.

Students' experiences with technology both in and outside of school may shape their view of what it is they are learning as well as how difficult the subject is to learn. For students who have had much experience with technology as a tool, the transition into the classroom may be an easier one. However, many students do not use technology as a tool but for other "social interaction" related practices. According to sociocultural theory, this too will help students to learn about and use technology in the classroom, albeit in a different format. Sutherland et al. (2004) argue that any experience with technology tools outside of the classroom will help student use them within a classroom setting as well.

Technology tools are as varied as the uses for them. From young elementary students through higher education students, experiences with technology are vast and diverse. Young students may start out with simple exposure to computers and different types of learning software and have technology experience all the way up to higher education where they may be charged with building their own web page and using email on a daily basis. Technology is definitely a part of classroom culture at any level. Although it is used in many ways and may have many meanings for teachers and students, it is imperative that those in the educational setting know how to use it.

4. Gender bias and technology

4.1. Research on teachers

The teacher in the classroom can play a large role in the everyday lives of the children they teach. Teachers play the roles of instructor, disciplinarian, helper and role model. Given that children spend so much of their time with teachers; it is not surprising that a teacher's expectations and actions may have a profound effect on the achievement of his or her students. It is no wonder there is concern as to whether some teachers may hold gender biases toward the children in their classrooms. Owens, Smothers, and Love (2003) suggest that what students are learning from their teachers reaches far beyond the curriculum and may be more powerful than lessons taught from textbooks. The attention the teacher gives his or her students can be a valuable asset in the learning process. However, research has shown that male students receive more attention from teachers and are given more time to talk in classrooms (Sadker & Sadker, 1986). For example, male students are given more opportunities to answer questions (Becker, 1981), more individual instruction (Stallings, 1985) and more encouragement and feedback (Morse & Handley, 1985; Serbin, O'Leary, Kent, & Tonick, 1973) than their female counterparts.

Examining teacher behavior, Sadker and Sadker (1986) identified four types of teacher reactions to students: praise, criticism, remediation and acceptance. Of these four, remediation, where the teacher helps the student to elaborate on an answer or idea, and acceptance, basic "okay" or "uh-huh" responses, were of most concern. Remediation would be most beneficial to students, helping them work through their own ideas and learn from that process, and acceptance would be least beneficial, providing no learning experience. Research findings show that male students received significantly more praise, criticism and remediation than female students, and acceptance responses were about equal between boys and girls (Sadker & Sadker, 1986; Stake & Katz, 1982). It has also been found that male students are more likely than female students to receive management-oriented contacts, including behavioral criticism and punishment (Jones & Wheatley, 1990; Serbin et al., 1973; Stake & Katz, 1982). Jones and Wheatley (1990) also reported significantly more interactions overall for male students than for female students. Altermatt et al. (1998) suggest that girls are shortchanged in the classroom because they are afforded fewer opportunities than boys to interact with teachers in academically meaningful ways.

Teacher's interactions with students play a large role in how children learn. Another type of interaction between students and teachers is direct questions in the classroom with either the teacher calling on students, students volunteering to answer, or students simply calling out answers (usually out of turn). Altermatt et al. (1998) found that boys and girls were called on equally when volunteering, however, boys volunteered more often than girls. They also found that in the sixteen 7th and 8th grade math and social studies classes they observed, boys were not only provided with more response opportunities overall, but were also given the chance to respond to more process questions (i.e., having the student build a logical argument to support their answer) than their female classmates.

Research in this area shows that boys in elementary and secondary schools are eight times more likely than girls to call out and demand a teacher's attention (Sadker & Sadker, 1986). Sadker and Sadker (1986) found that teachers behave differently depending on whether the student calling out is a boy or a girl. They found that when boys call out, teachers tend to accept their answers, but when girls call out teachers remediate their behavior and advise them to raise their hands. Studies related to this trend have shown that girls are more likely than boys to receive feedback that is irrelevant or social reinforcement that is inconsistent with the quality of their work (Owens et al., 2003). Girls are more likely than boys to emphasize the successes of their classmates while also emphasizing their own failings (Frey & Ruble, 1987). Even those girls experiencing success make more modest attributions than their male counterparts who experience success (Gould & Slone, 1982).

Examining teacher use of technology is yet another area in which gender bias may manifest itself. When technology was introduced into the educational setting in the early 1980s, few teachers were aware of what types of technology were available to them, how they could be used, and how they might benefit the learning experience for them as well as their students. Technology was varied in a number of ways. It was seen as the use of computers and later the Internet, it was thought of as different modes of presenting information to students (i.e., videos, projectors, slideshows, etc.), and it also comprised new ways of aiding students (e.g., advanced

calculators for math), a new area to include in the curriculum, and new ways of testing students' achievements. Since its initial introduction to the classroom, technology has been seen primarily as a positive advantage in education.

Goodman (2001) suggests that technology in its many forms can create new learning environments for students that will enhance basic learning processes. Technology can create myriad possibilities for instruction, making it easier for educators to facilitate all learning styles. Although this may be the case, studies on technology in the classroom have been difficult to compare. Many see different aspects of the classroom environment as technology related. Pflaum (2004) reports that different types of technology-based curriculum are being used throughout classrooms in the United States. He reports varied experiences for both educators and students using computers as a main staple in the classroom. For example, one classroom may simply use computers for word processing purposes whereas another classroom may be involved in Internet searches and development of web pages. This difference in level of use of technology makes it difficult to compare teachers' and students' perceptions of the effectiveness of technology in the classroom.

In fact, many educational systems are pushing toward a more technology-based, interdisciplinary curriculum in their schools. Following the No Child Left Behind act in 2002, many schools were left with little option but to encourage the integration of technology with their existing curriculum (Pittman, 2003). Pittman (2003) points out that these changing roles for teachers may have been difficult for some, as the knowledge of technology may have been lacking, the appropriateness of some technology tools were in question, and the quality of how the tools were and would be used was varied. Although most teachers would agree that using computers and technology in the classroom could benefit the learning environment for students by promoting active engagement in topics studied, some disagree on its contribution to the social context of a classroom (Taylor, Casto, & Walls, 2004).

It had been assumed that the use of computers could serve to isolate students from peers as well as teachers and take the place of group interactions and class discussions (Goos, Galbraith, Renshaw, & Geiger, 2003; Westby & Atencio, 2002). Fearing this was the case, especially in math and science classrooms, where group activity is typically promoted, Goos et al. (2003) looked at the ways in which technology was being used in math classes. They found that what had been feared was not so. The technology being used in the classroom was actually furthering group discussion and interaction instead of serving to hinder it. For example, students in the math courses using technology tended to work in groups at a "station" where they could each ask questions of each other, have input to what they were studying, and ask questions to the teacher as group. This finding has been reported by others in different areas of education as well (Crook, 1996; Ng & Gunstone, 2003; Taylor et al., 2004).

In fact, Ng and Gunstone (2003) found that although there is limited evaluation on teacher use and effectiveness with technology tools, most teachers have a positive view of using technology in the classroom. The biggest obstacle for teachers may be that they do not feel competent to use certain types of technology in their classroom. Although many teachers may learn about technology and the basics of how it works, they are not learning how to use it as a tool in their classroom (Gimbert & Cristol, 2004). Gimbert and Cristol (2004) suggest that there should be more of a focus in teacher–educator programs on how to use technology efficiently at different levels of education and with different student populations. Schofield (1995) also suggests that teachers need to be more prepared for the change technology can bring to the classroom environment. Although it may enhance student learning on a number of levels, it may introduce certain types of bias for students (e.g., boys tend to have more prior experience than girls, male teachers tend to use technology more than female teachers, stereotyped course material, etc.) and add a level of difficulty for others. If teachers are prepared for how to use technology in the classroom, its effective use could act to improve the overall quality of education, including classroom environment.

The number of teachers using technology in their classrooms is continually increasing. Research has shown however, that many teachers are not being educated as to the type and level of gender bias that exists in the technology they are using (Caftori & Paprzycki, 1997; Strauss, Shaffer, Kaser, & Shaw, 1988; Zittleman & Sadker, 2002). For example, many students in teacher education programs do not take courses that discuss the topics of gender bias or technology. A select few may have room in their schedules to take elective courses covering those topics however neither tend to be required for many programs and very rarely are they discussed together (Zittleman & Sadker, 2002). Strauss et al. (1988) reported that teachers need to be aware of the fact that female

students tend to avoid computer usage more than male students. They assert that this is due to the myth that computer usage requires mechanical or higher mathematical skills. Due to the lack of female students in courses available in secondary education such as computer literacy or computer science, they argue that female students have less access to experience with computers. Access to computers and experience with using technology play a large role in the interest of women to go on in technology-related fields in higher education.

Strauss et al. (1988) further state that because of either lack of role model or leadership of female teachers, the preparation and education female students receive is placing them at a disadvantage in the workforce. They report that the same percentage of women graduate with bachelor degrees in quantitative sciences and engineering as did in the 1920s. They also point out that women in these fields are generally devalued as evidenced by their lower salaries than men's. Because of barriers like these, our teachers and role models may have to learn what inspires young women to pursue careers in math, science and technology-related fields.

A similar study by McClelland (2001) urges teachers to help close the gap for equal representation of women in technology jobs. McClelland (2001) points out that female students tend to have less experience with computers and technology-related tools outside of the school setting and because of this need to gain ground in their participation during school. She urges educators to use examples highlighting female role models in math, science and technology fields, to make certain that underrepresented groups have access to computers, to require that all students be computer literate – not just those expressing interest, that they be aware of any implicit biases they may be holding about women in technology, and that they help foster self-confidence especially in female students. McNair, Kirova-Petrova, and Bhargava (2001) agree, stating that teachers should be charged with the responsibility of minimizing bias in computer use by being aware of barriers that hold girls back from computer learning in school. While all of these suggestions seem appropriate for the classroom setting, many teachers are not getting this type of instruction in their own education to become teachers (Zittleman & Sadker, 2002). Unfortunately, the gender inequities teachers may employ on a general level can involve biased expectations for math, science and technology-based career fields.

4.2. Research on students

There are some suggestions in the literature about why teachers may hold gender biases, however some have taken the blame off of teachers, arguing that teachers respond to the different behaviors of their students rather than their sex or other background (Bank, Biddle, & Good, 1980). Altermatt et al. (1998) agree with this theory, at least for younger students, stating that gender differences in elementary school classroom experiences may be due to the gender role-related differences in the behavior of the students themselves rather than to any general tendency for teachers to treat boys and girls differently.

It has been suggested that students in the same classroom, with the same teacher, studying the same material, experience very different educational environments (Sadker & Sadker, 1986). Research in both experimental (Parsons & Ruble, 1977; Sax, 1994) and school settings (Eccles, Midgley, & Adler, 1984; Eshel & Klein, 1981; Nicholls, 1978; Stipek & Tannatt, 1984) typically shows that self-ratings of perceived competence are very high in pre-school and kindergarten, but decline markedly thereafter. Frey and Ruble (1987) state that what is even more puzzling, given that actual performance differences often favor girls in the early grades (Maccoby & Jacklin, 1974) is that girls frequently express less positive self-evaluations than boys, and that some of the most able girls have the lowest expectations.

As early as kindergarten and first grade, sex stereotyping is evident and lack of parental expectation, evaluation, and encouragement may discourage girls from excelling in math, science and technology. These early educational differences result in discrepancies between the science achievement levels of boys and girls as early as age 13 (Kahle & Lakes, 1983). Sex "appropriateness" of subject matter may play a part in the choice and achievement differences in science courses (especially the difference between chemistry, which is more math oriented, and physical science where chemistry favors boys) when teachers and students view some subjects as masculine and feminine and act accordingly (Jones & Wheatley, 1990). These gender-role linked trends may be the barrier keeping female students out of math and science oriented careers (Bazler & Simonis, 1991). Kahle and Lakes (1983) reported that 51% of the male students compared to 8% of the female students in an incoming University of California – Berkeley class had completed four years of high school math. This lack of courses may also prevent female students from obtaining careers in the sciences.

There is great diversity among students at most public schools in the United States. Some students may simply not be interested in math, science or technology-based classes. Examining this area may also help determine where gender biases exist among students. Kahle and Lakes (1983) found that although at age 9 many female students were interested in science experiences, by age 13, this interest decreases. Girls in both age groups had lower aspirations in science-related fields than did boys, were less interested in learning about science careers, and felt less confident that there were science jobs they could learn to do. Kahle and Lakes (1983) also found that the number of actual science experiences for boys exceeds that for girls in every area surveyed including science observations, instrument skills, field trips, experimental tasks and extracurricular activities. Gender inequities are most evident in observations of team work in lab assignments where female students are less likely to be involved in operating lab equipment. Boys can be seen manipulating the lab equipment, verbally providing the observations and girls recording the data in the lab notebooks (Guzzetti & Williams, 1996).

Students report discussion to be an activity that contributes most to science learning. Yet, both true discussion and recitation-type discussion is dominated by male students (Guzzetti & Williams, 1996). Discussion that disenfranchises female students is especially detrimental in science since researchers argue that it is particularly important to discuss ideas when student's theories are contradicted by scientific thought (Guzzetti & Williams, 1996). Guzzetti and Williams (1996) explore three possible reasons as to why male students talk more in classroom settings. The first is that there is a cultural proclivity for seeing any talk by girls or women as too much talk. Spender (1979) also found that women in group conversations could not talk more than half of the time without making the men feel threatened in some way. Holmes (1992) found that women are perceived as talking more than men even when they are only talking about 30% of the time. The second is that social pressures require that girls and women should be good listeners, their verbal participation is seen as less important than their ability to be attentive to others. The third is that girls and women are discouraged from talking by such verbal and nonverbal means such as gaze aversion, delayed feedback, interruptions and withholding of active listening responses, like nods or requests for elaboration.

Advancing technology held some optimism in this area as computer-mediated forms of communication became available. There was belief that this type of communication would be inherently more democratic than face-to-face communication (Herring, 1993). Educators began using this type of communication in the classroom in order to foster creativity and break down traditional barriers. Subsequent studies conducted in this area found that although computer-mediated communication (CMC) was assumed to hold differing psychological and social aspects from human communication, this was not entirely the case. Sierpe (2005) pointed out that CMC tends to differ from other types of human communication in the language used, the openness of the users to discuss certain topics, and anonymity. Poster (1990) argued that gender inequality would not be significant in a virtual environment given the anonymous nature of this form of communication. Postmes and Spears (2002) however found no support that anonymity would lead to equalization. Furthermore, Sierpe (2005) points out that CMC is not devoid of the hierarchical structures of communication that promote gender bias, but in fact only serve to recreate existing norms and biases despite supposed anonymity.

Guzzetti and Williams (1996) state that it is important to involve students in the change of the dynamics of the classroom because female students may be restrained by their fear of male students and not the teacher. Other suggestions to remedy student's behavior have been classes to make students aware of gender biases and same-gender work in math and science classes to allow for girls to get a better chance at being involved in the hands-on experience of their own education. These suggestions may serve to encourage female students to pursue math, science and technology-based career fields in higher education.

Ayalon (2003) suggested that women are underrepresented among applicants to fields of study in higher education that are math related, even when they have a strong high school mathematical background. For those women that do enter higher education to pursue math-related career fields, they have been shown to leave their selected field at a higher rate than their male counterparts (Sax, 1994). Sax (1994) proposed that the most confident female students in math are becoming less confident throughout their college careers. In an effort to understand what variables may keep confident female math students in their fields of choice, Zeldin and Pajares (2000) looked at women who excelled in careers that are math, science or technology based. They found that the self-efficacy beliefs held by these women were highly influenced by verbal persuasion and vicarious experience, both of which are lacking for the girls and women in our schools.

Attitudes toward student use of computers and technology in the classroom are also varied. Some educators believe that computer use may increase student motivation while others believe that students will fail to use computers as intended and will experience a lack of education by doing so (Westby & Atencio, 2002). Westby and Atencio (2002) pointed out that computers can play different roles for student use. They proposed that they can be used as a tutor, leading students through rote memorization tasks, a tool, for students to gain information, and a tutee, where a student can program the computer to perform some task. Although all of these roles may be useful on some level, Westby and Atencio (2002) argue that it is only the last role that will help students learn. Yet, they found that computers are being used most often for gathering information and entertainment. Nonetheless, when computers are used in the role of tutee, students may not be gaining the knowledge they are intended to. Westby and Atencio (2002) suggested that only when students are asked to explain what they are doing (i.e., interacting with a teacher or another adult), do their achievement in the task as well as their problem solving ability increase.

It has been reported that students have varied experiences with computers and technology (Pflaum, 2004), making it difficult to compare the effectiveness of using computers in the classroom. Despite teacher expectations that computers will enhance achievement, little research has been conducted that show this to be the case (Cuban, 2001). Christmann and Badgett (2003) reported that elementary students' academic achievement was improved by supplementing traditional instruction with computer-aided instructional (CAI) software. The effects of CAI alone however, remain equivocal. A similar study conducted with college students showed that students only used the CAI supplement when they needed support to complete coursework assignments (Saunders & Klemming, 2003). Saunders and Klemming (2003) also reported that student attitudes toward the supplement module were positive even though they perceived it to be more difficult than usual classroom sessions. It would seem that although students have a positive perception of technology, it may not be to their advantage to be using it in the classroom environment.

Crook (1996) focused on the social environment in the classroom and how computers can aid students in collaborative learning exercises. Whereas many researchers are concerned about how the use of technology may undermine the social experience of the classroom, some have argued that it enhances social facilitation for students (Crook, 1996; Schofield, 1995). Students who are able to use computers effectively in group work exercises may be better equipped to learn diverse communication skills, including computer-based communication as well as face to face interaction (Westby & Atencio, 2002).

Furthermore, studies based on sociocultural theory have looked at varying ways technology can be used in social interaction within the classroom. Stahl (2005) looked at the role of instructional technology on group cognition. Within a collaborative learning environment, Stahl (2005) highlights some of the uses of technology in the classroom on developing shared meaning. Löfdahl and Hägglund (2006) found that pre-school children equate "play" with social participation and use it as a form of power over one another. Given that many formats of technology are first learned as a form of play, even in school, this way of playing may be serving as a tutor for socially constructed gender roles regarding who holds the power and who does not.

Despite the disagreement in other areas of technology-related research, there seems to be quite a consensus that male and female student experiences with and attitudes toward computer use differ greatly. Many researchers have come to the similar conclusion that male students have more computer experience than female students, male students use the computer for different reasons than female students, male students have more positive attitudes about computers and technology than female students, and male students receive more encouragement to use computers and technology tools from parents and friends than female students (Ames, 2003; Busch, 1995; Colley, 2003; Lockheed, 1985; Schofield, 1995; Shashaani, 1994).

Some have viewed the barriers that seem to be in place for female students' technology use as administrative, instructional and curriculum related (Damarin, 1989). Others have identified learning styles as a possible association with students' affinity for and dislike of computers and technology (Ames, 2003). Davis (2001, p. 185) defines the term learning styles as referring to "individuals' characteristic and preferred ways of gathering, interpreting, organizing, and thinking about information." Ames (2003) found that use of computers in instruction may not be beneficial for all students and suggested that more information is needed before technology is introduced in all aspects of curriculum. For example, some students may prefer to work in groups as opposed to alone, or to read information as opposed to hearing it relayed to them. Certain learning styles may lend themselves to an affinity to working with computers and technology tools, whereas others may not.

Lockheed (1985) looked at how male and female students use computers and the subsequent cognitive effects that may play a part in their computer use. She found that boys and men tended to use the computer for game-playing and programming, whereas girls and women were interested in the use of the computer as a tool for task completion (e.g., writing homework papers, keeping track of financial information). She also found that the cognitive effects of computer use were similar for both men and women. This study was one of the first conducted in the area of how female and male student use technology and computers and many similar studies have been conducted since.

Although computers are used in the elementary school setting, they are much more prevalent among secondary and higher education classrooms. Shashaani (1994) looked at secondary school students' experiences and attitudes toward computers in school. Findings in this study were similar to the previous in that boys both had more experience with computers as well as more positive attitudes toward them than girls did. One interesting finding was that more households of male students were found to own a home computer than households of female students. Concurrent with this finding was that over half of the male students reported having computer experience before reaching the school setting whereas the same trend was true for female students having their first computer experience in the classroom. Another unique finding of this study was that for boys and girls who attended computer classes, the boys reported more confidence in their ability with computers following the class, whereas girls' confidence in their ability did not increase. It may not be enough to simply have female students take computer classes, they may need the encouragement and outside experience that boys are receiving to achieve equitable experience with computers and technology.

In another study of secondary education students, Colley (2003) found again that boys used the computer for playing games and girls for work and completion of tasks, although no computer use was required by any student. She also found that the way in which students used the Internet was different. Boys tended to use it for searching while girls used the Internet for e-mail more often than boys. They also found differences in responses to what students' found to be the worst aspect of using computers at school. Secondary education male students in this study reported limited access to computers as the worst aspect (even though they have been shown to have better access than female students) whereas female students reported specific applications such as spreadsheets and databases as the worst aspect of computer use at school, again highlighting the differences of how male and female students use computers differently (e.g., female students only used it for work, so found the worst aspect to be the difficulty of certain programs used for that purpose). Colley (2003) suggested that the link between mathematics and programming and applications like spreadsheets and databases may be why female students dislike that aspect of computer use.

Students at the higher education level also show a gender bias in technology-related fields of study (Russell, 2004). In fact, women tend be consistently underrepresented in technology-related fields (Traut, 2002). Many reasons have been explored as the potential cause for this bias. Some believe that women are discouraged by society from pursuing such career goals, others have stated that it is gendered learning styles (e.g., women tend to prefer learning styles that are group and discussion oriented whereas men tend to prefer lecture type or hands-on learning styles) that play a role in the courses University men and women enroll in, and still others look at the effects of self-efficacy on computer use and attitudes (Ames, 2003; Busch, 1995; Russell, 2004). Russell (2004) pointed out that women do not tend to be less interested in computer science or less skilled in technology-related career fields, but that they face many social barriers to becoming successful in those fields.

Ames (2003) found that although computer use may be a predominately male activity in earlier educational settings, once students reach higher education, the difference decreases dramatically (in some schools it disappears completely). In fact, many universities now have a computer literacy requirement for all incoming students. This requirement may be beneficial for those attending college or university, but may also exclude a large number of female students from entering due to their lack of experience with computers during their elementary and secondary education experience. Ames (2003) also points out that female students tend to have learning styles or preferences that may not benefit from a technology-oriented curriculum. For example, female students tended to prefer smaller, discussion oriented classes as opposed to larger lecture oriented classes, which are becoming more frequent and easier for instructors to offer with technology such as PowerPoint and Personal Response Systems. Another finding of this study was that reduced computer anxiety for female students served to increase confidence, which Ames (2003) argued may result in increased interest in technology-based fields. This potential increase in confidence has been the focus of other studies.

Busch (1995) looked at self-efficacy among college students following simple and difficult computer tasks. Similar to other studies, Busch (1995) also reported that male students had more previous experience with computers than female students as well as more encouragement to use computers than their female counterparts. Other findings included gender differences for complex computer tasks (e.g., programming), where male students reported higher self-efficacy than female students; and no gender difference was reported for simple tasks (e.g., word processing). When looking at positive computer attitudes, the strongest predictors were computer experience and encouragement, both favoring men. In fact, encouragement was shown to be a stronger predictor of positive computer attitudes than was self-efficacy. All predictors tended to favor men over women. With strong gender expectations about computer use and technology-related career fields coupled with lack of encouragement and experience for women, gender equity in technology appears to be an uphill battle.

4.3. Research on materials

The tests and texts used in elementary, secondary, and higher education classrooms are used to instruct, guide, and give information as to how the students in the classroom are performing in school. Campbell (1986) stated that in elementary years, when sex differences are found in mathematics achievement, they tend to favor girls. By junior high, half of the few sex differences found in math favor girls. In high school and beyond, the many sex differences found in mathematics achievement favor boys. Sadker and Sadker (1986) reported similar findings. They stated that in the early grades, girls' scores on standardized tests are generally equal to or better than boys' scores. However, by the end of high school, boys are scoring higher on such measures as the National Assessment of Educational progress and the Scholastic Aptitude Test (SAT).

The same trend is also found in chemistry, biology, and physics achievement tests and the verbal, analytical, and quantitative sections of the GRE (Jones & Wheatley, 1990). Hyde, Fennema, and Lamon (1990) found that there are few sex differences reported in math until about ages 12–13, when boys' math skills increase faster than girls'. This is also indicated by data from the National Center for Educational Statistics (NCES) which shows that achievement test scores of high school seniors in 1972 support the relationship between female students and verbal ability and male students and mathematical ability. Boys achieved higher scores in math, girls in reading and vocabulary. Between 1972 and 1980, the advantage of females over males in reading was all but eliminated. Boys actually outperformed girls in vocabulary in 1980 and they continued to maintain their edge over girls in math (Harvey, 1986). Hyde et al. (1990) report that gender differences were found to be the largest (with males outperforming females) on standardized tests testing a mixture of cognitive levels.

Textbooks are an integral part of instruction and can give messages about science and society as well as science careers. They are a primary source of information in elementary and secondary classrooms (Bazler & Simonis, 1991) as well as higher education classrooms. Research tracing changes in science textbooks over time has shown that current texts have failed to eliminate barriers to women in science. Science textbooks are criticized for their unequal treatment of gender with illustrations, photos, and texts of men far outnumbering that of women, despite the approximate 50/50, male/female ratio of our population (Guzzetti & Williams, 1996). In a study conducted by Bazler and Simonis (1991), they compared seven chemistry textbooks from 1973 to their updated editions in 1988 to see if gender equity was greater or achieved in the texts over a fifteen year period. They looked at illustrations, photos, and texts of youth, named adults, and unnamed adults. Results indicated that only one text changed dramatically in overall proportions of male/female images and only one text showed a significant increase in representations of female youth, with two of them showing the opposite movement toward increased disproportion of male youth images. Ratios of illustrations of named and unnamed adults improved measurably in only two texts. Overall gender ratios improved from five male images to every female image in 1973 to three male images to every female image in 1988. Only one text showed gender equity.

Similarly, texts used for computer science courses have also been criticized for their stereotypical content. Schofield (1995) pointed out that although no formal content analysis was conducted, she found many examples of gender-biased texts in the classrooms she was studying as well as on the library shelves. For example, Schofield (1995) observed many texts related to word processing and other "secretarial-type" skills to have pictures of female secretaries on the cover. Texts related to computer hardware or programming however, typically featured men on the cover. Other materials were also observed by Schofield (1995) to contain

stereotypical roles or messages, such as movies and worksheet handouts that portrayed people using computers and other technology in gender stereotyped ways.

According to Webster's New World College Dictionary (2000), the term technology can be defined as the science or study of the practical or industrial arts, applied sciences, etc. As evident by its definition, technology can mean a number of things and be applied to many facets of the educational setting. Typically, technology in the classroom is defined by access and use of computers. This can be supplemented however by different types of computer software used, different ways of presenting information to students (e.g., videos and slideshows), and advanced instructional design (i.e., using technology in the curriculum to teach other lessons). Empirical research on the effectiveness of different types of technology use in education is limited. Furthermore, very little data is available regarding what types of technology in the classroom are beneficial and which are not, how they can be used successfully, and if the materials considered being technology-based are advancing students' knowledge in the area of technology.

A couple of studies concerned with how the use of technology in the classroom (computers) effects the social environment and the function of the classroom, have found computers to be used in a number of ways (Crook, 1996; Schofield, 1995). Crook (1996) found that although computers are often intended to be used by students solitarily, they are also effectively used by two or more students at the same time. Schofield (1995) reported similar findings, but warned against how the computers were being used. Computers that were in the classroom for the purpose of promoting particular types of learning, were often being used for entertainment purposes only and it is for entertainment purposes that students are sharing computer space and not during lesson activities (Schofield, 1995).

Technology materials are used differently depending on the level of student being taught. Tools used in elementary classrooms are much more limited than what can be used in secondary and higher education classrooms. One controversy that exists in early childhood education literature is the use of developmentally appropriate software in the curriculum of young children (Gimbert & Cristol, 2004). Gimbert and Cristol (2004) suggest that children can benefit from the use of technology tools (e.g., CD-ROM literature) but still need the input of the teacher or other adults to understand how technology works. Technology tools alone are not sufficient to help young children learn a concept or lesson.

Secondary education students have more options available to them from the vast field of technology tools. Not only are computers used on a daily basis in many high schools, but tools such as graphic calculators, personal response devices (PRD), and PowerPoint slides to supplement lecture material are used frequently. Goos et al. (2003) looked at the use of computers, graphic calculators and PRD in secondary math courses. They found these tools to be used in varied ways, with the most useful being the PRD. Students reported that the use of PRD facilitated group and class discussion about concepts that were difficult for them to understand, whereas the computers and calculators were used more for working problems out and not for understanding how to do them. These findings would suggest that technology tools that can be used collaboratively may be most beneficial for student use in classrooms.

Higher education classrooms have even more technology tools available to them. Zhu and Kaplan (2002) identified eight types of technology tools available to higher education classrooms: communication (e.g., email), organization and presentation (e.g., PowerPoint), information search and resource management (e.g., PsychInfo), audio and video, web-based course management (e.g., Blackboard), creation and manipulation (e.g., HTML editors), discipline-specific software programs (e.g., SPSS), and distance learning systems. Most of these tools are used to some extent or another by students in higher education classrooms. Although many tools exist for use in higher education classrooms, there is debate about whether or not these tools be used for ease of instruction or to advance student learning. Some researchers have argued that technology tools can only be used for providing information and do not affect student learning (Clark, 1994; Russell, 1999). Others believe that because the research is so varied and technology tools largely unexamined that there may be some student learning outcomes that are affected by the use of technology in the classroom that are still unknown (Ehrmann, 1995; Kozma, 1994). In the midst of this debate is the general consensus that technology tools should be used in one way or another. If they are meant to simply help provide information, considerations need to be made for all students to have access; if they are meant to support student learning, instructors should be aware of the changes they may make in teaching and learning processes (Zhu & Kaplan, 2002). Technology tools can be used effectively in the classroom; however they can also be detrimental to students when

instructors do not pay attention to how students are using them (e.g., if they are being used inappropriately or not at all), which students are using them (e.g., if only a select few are gaining an advantage by using the technology provided), and if they are really aiding the learning process or if they are being used for technology's sake only.

Gender biases in the way computers and technology tools are used by students in the classroom and by the messages they may send to students who use them were not concerns educators and researchers foresaw. Predictions when computers and advanced technology first entered the educational setting were that these tools would serve to equalize gender biases in the classroom (Watt, 1984). Others argued however that technology cannot further gender equality. Kilbourne and Weeks (1997) state that technological design is developed within a patriarchal society and therefore even the design itself will hold gender bias. A number of researchers have identified gender biases in educational software (Bhargava, 2002; McNair et al., 2001; Sheldon, 2004) as well as computer collaboration and space (Ching, Kafai, & Marshall, 2000; McNair et al., 2001). Computers are by far the most used technological tool in the classroom setting and cannot be used without the aid of software.

Educational software packages are typically designed for young children in the classroom. This may be a child's first experience with computers and technology and in turn can play a large role on how children view technology tools in the classroom. Sheldon (2004) identified, through content analysis of educational software, gender representations and stereotypes of 48 different types of educational software packages designed for young children. Results were overwhelmingly gender biased. Sheldon (2004) found significantly more male main characters than female main characters, although there was no gender difference for secondary characters. Female characters although engaging in more counter-stereotyped behavior were more gender stereotyped in appearance than male characters. Sheldon (2004) pointed out that although many software packages included both male and female characters, just as many included male characters only. This limits the options available to girls using computer software that would much rather use software with characters they can identify with. DeJean, Uptis, Koch, and Young (1999) reported that girls are much more engaged in computer use and feel more comfortable when using software packages with female main characters. Sheldon (2004) argued that the mixed messages being given to girls by having female characters behave in stereotyped masculine ways yet have a very feminine appearance may serve to promote the idea that no matter what their behavior, they are expected to appear feminine. In other words, it does not matter what they do, only how they look.

A similar study of children's software programs also found subtle yet pervasive gender bias in characters, content and reward systems (Bhargava, 2002). Bhargava (2002) stated that one explanation for the discrepancy in computer use between male and female students is the bias of the software programs being used in the classroom. Although female students may want to engage in computer use and technology-related activities, it may be difficult for them to stay interested when they have no choice but to use programs they have difficulty identifying with. It is imperative to develop and promote gender equitable software programs for students, as well as teach educators how to choose appropriate software for their classrooms.

McNair et al. (2001) also found gender biases in computer use and software packages for students. They point out that not only are software packages biased, but the technology resources available for students tend to attract boys more so than girls. Even software aimed at education tends to promote competition where characters are involved in rough or violent behavior, rather than prosocial actions or speech. Bradshaw, Clegg, and Trayhurn (1995) found that even when androgynous characters are used in software packages, children tend to assign male gender to the characters. McNair et al. (2001) argued that there are not enough female role models showing competent computer skills in school. The negative effects this may have on our female students may be heightened by the misuse of biased software.

In order for students to use any software packaging, they must have access to use computers themselves. Ching et al. (2000) examined the differential access students have to computer use during a given task. They found that an equitable distribution of labor on the assigned project was difficult to attain. They found that girls lacked access to computers throughout the project more so than did boys and girls used the computer in different ways than did boys. Not surprisingly, boys were more interested in aspects of the project that resembled games and promoted programming, whereas girls were interested in completion of the task and collaboration with peers. Ching et al. (2000) submit that when girls have limited access to computers and technology resources, they may not only show deficits in computer skills, but other subject matter being taught through computer use.

5. Discussion

In many ways, gender bias and technology are two very different concepts. In fact, it had been assumed that technology for the most part was gender-neutral. In the classroom setting however, this may not be the case. Teachers may be serving to promote computer use and technology-related activity to boys more so than to girls. Teacher education should strive to include instruction on the use of technology and the biases that may exist in technology in the classroom. Teachers may also need to pay more attention to how they are held up as role models by encouraging female students to use computers and be involved in activities using technology tools to help overcome some of the socio-cultural biases that serve to hold girls and women back in these areas.

The students themselves seem to have different interests in computer use and technology tools, serving to further gender bias in technology-related career fields later in life. Female students' attitudes toward computer use are less positive than that of their male counterparts, due in part to lack of experience with computers and technology tools as well as the differences in use of such tools. Female students need better access to computers and technology in order to gain the experience that male students seem to have. Social barriers that hold women back from math, science, and technology-related instruction in the education setting may be serving to keep them out of analogous career fields.

Materials used in the classroom to promote technology (and in some cases to promote gender equity) may also be doing harm by holding gender biases in the way they are presented. Educational software packages that promote gender-biased characters and sex-typed behavior are destructive to the educational experience of girls and women not only because they promote socially constructed gender roles that may serve to hold girls and women back in technology-related fields but also because females will likely be less interested than males in technology when they are largely "left out" of the experience. Computer access and collaborative space is also lacking as a tool for female students to use in the classroom. Although this bias is seen in girls' and women's lack of computer experience it may also be manifesting itself in other areas of education when computers and technology are used for instruction of other subjects.

5.1. Criticism of research

The literature on gender bias and technology in education is both vast and varied. Many criticisms of methods used to study gender differences in technology have been asserted. Kay (1992) pointed out that researchers have focused on the differences in attitudes toward computers, aptitude and experience or use of computers. She identifies a number of problems with studies looking at gender differences in computer-related behavior. Sample selection in educational research is often drawn by convenience sampling or relied on by volunteers, this can pose problems statistically. Scale development and quality are other criticisms of research in this area as the scales used tend to be varied (i.e., difficult to compare) and there is a lack of reporting on reliability of the scale items used. Statistics reported are another area that is either lacking sufficient information in many studies or mistakes are made in the statistical analyses and findings are then misreported. The constructs used in examination of gender difference in computer-related behavior tend not to be operationally defined and are therefore difficult to test. The last criticism Kay (1992) makes of research in this area is the informal presentation of results. She points out that many researchers do not provide enough information to know if the results they are stating are accurate, and suggests that researchers present more (i.e., type of computer being used, classroom environment being studied), not less information so studies can be critically evaluated.

5.2. Agreement among research

Despite these criticisms to a large body of literature, there tends to be agreement in many areas of research on gender bias and technology in the classroom. The effects gender bias and technology in education have on teachers are numerous. Many recommendations have been made of how to handle the shift in their role as teacher when technology is introduced in their classroom. Teachers that are using technology in their classrooms are not only having to learn the technology itself, but the advantages and disadvantages it may have for their students, including inherent biases the technology itself may hold. Although technology is being used in the classroom more frequently, teacher education programs do not tend to have strong emphases on gender

bias in technology and its use in education. Teachers need to be responsible for the role models they may hold up for students (especially female students), the access they give students to technology tools, and the differential encouragement they may be giving male and female students to enter career fields in math, science and technology.

Students have also been shown in a number of studies to hold gender based expectations of each other and carry out gender-specific roles in the classroom. Students learn these ideas and behavior from places other than school and teachers and educators can only strive to counteract some beliefs students carry with them. Female students may have less experience with computers and technology tools because they are less interested in the things they are used for. Female students tend to be drawn to collaborative classroom activities whereas computer use tends to be a solitary activity. Male students may have a more positive attitude toward computer use because of their greater experience, encouragement from parents and peers, and interest in computer activities. One possible reason female students may enter math, science and technology-related career fields in fewer numbers than male students may be their lack of experience, interest, and positive attitude to perform such tasks in school.

Materials used in the classroom aimed at advancing technology may also hold gender biases. Not only do tests and textbooks show gender inequity, but software programs and access to computer use also heighten gender differences in the classroom. Educational software packages as well as the lack of collaborative space for computer use in the classroom have been shown to promote gender biases. It seems that girls and women are strongly underrepresented in many facets of the educational setting. Tools and materials that are assumed to be gender-neutral hold biases that may be sending messages more influential than teacher and student interaction. Although these areas seem the easiest to change, they remain untouched throughout the years of research in the literature.

5.3. Recommendations

Despite the limitations and criticisms of the numerous and diverse research on both gender bias and technology in education, some recommendations have been made (Goodman, 2001; Pflaum, 2004). Goodman (2001) pointed out that instructors often overlook the important issue of whether technology or learning is driving education. He cautioned against letting technology drive how classroom environments are managed and recommends that all teachers be aware that learning should come first and that not all technology tools will serve to promote that aspect of education. Teachers should not overlook the maintenance of gender equity in their classrooms simply to increase the use of technology for their students.

Similarly, Pflaum (2004) makes four recommendations for using computers in the classroom. First, he recommends focusing computer use and instruction on students who will benefit from it most. Female students, being at more of a disadvantage than male students, may need additional instruction and/or access to computer use in the classroom setting. Second, he recommends using computers to support instruction and classroom assessment. Although many teachers are using tools such as PowerPoint and personal response devices, many do so without knowing whether or not they actually are supporting their instruction.

Third, he recommends using computers for student assessment. Teachers can benefit from their ability to correct tests automatically and students can benefit from receiving quick results. Last, he recommends using computers in the classroom at an age-appropriate level. For students who are not receiving computer experience outside of the educational setting, starting them at a point that is too advanced may serve to lessen their interest and further negative attitudes toward computer use in the classroom. Overall, teachers should be aware of the impact of both gender bias and technology in education. They should take care to not overlook one for the other and realize that although technology tools are assumed to be gender neutral, they may be promoting gender biases in a number of ways.

6. Conclusion

Gender-biased education has been examined for many years and has been shown to exist in three main areas: teacher instruction, student social interaction and materials used for teaching and learning. Over the course of identifying ways in which bias is inherent, researchers and educators have also proposed many ways

of reducing or eliminating such bias. As the instances of gender-bias were thought to have started to decrease in our classrooms, other concerns about the way in which students learn were brought to light.

The effects of technology in the educational setting have been widely investigated. Biases that have existed in the many areas of the educational system (i.e., teachers, students, materials) have not magically been solved by the introduction of technology (as some had hoped). In fact, these biases may have simply been converted into a new form that may also serve to undo some of the bias-elimination that had started to take place in many classrooms. Technology in the classroom has been seen by educators as a way to enhance student learning. While technology is becoming more of a necessity in the classroom because of its widespread use, concerns about the disadvantages technology may produce in education have been set aside. As technology in the classroom increased and was intended to make education easier for all students, it has actually served to increase gender-bias in all three main areas of education; the very areas in which educators had been previously attempting to decrease gender-bias. As the process of learning and teaching technology to students becomes the main focus of education, educators are neglecting to maintain their bias-free classrooms. Furthermore, technology itself has been shown to hold gender-biases that reduce equity in the classroom, adding to the areas educators and researchers need to be aware of when attempting to reduce or eliminate gender-bias from classroom environments.

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